

Supplementary Document

Table S1. The detailed search strategy

Database	Search strategy	Search date	Total number of identified articles
PubMed	(((("sleep initiation and maintenance disorders"[Mesh]) OR (disorders of initiating and maintaining sleep[Title/Abstract]) OR (DIMS[Title/Abstract]) OR (sleep initiation dysfunction*[Title/Abstract]) OR (sleep initiation[Title/Abstract]) OR (initiating sleep[Title/Abstract]) OR (early awakening[Title/Abstract]) OR (wake up early[Title/Abstract]) OR (waking up early[Title/Abstract]) OR (wakeful*[Title/Abstract])OR (sleeplessness[Title/Abstract]) OR (sleepless[Title/Abstract]) OR (sleep difficult*[Title/Abstract]) OR (difficulty in falling asleep[Title/Abstract]) OR (fall asleep[Title/Abstract]) OR (falling asleep[Title/Abstract]) OR (difficulty in maintaining sleep[Title/Abstract]) OR (maintain sleep[Title/Abstract]) OR (sleep maintenance[Title/Abstract]) OR (maintaining sleep[Title/Abstract]) OR (sleep impairment[Title/Abstract]) OR (sleep disturbance[Title/Abstract]) OR (sleep disorder[Title/Abstract]) OR (insomnia[Title/Abstract]) OR (sleep quality[Title/Abstract]) OR (poor sleep[Title/Abstract]) OR (sleep efficiency[Title/Abstract]))) AND (("glycemic control"[Mesh]) OR ("blood glucose"[Mesh]) OR ("glycated hemoglobin"[Mesh]) OR ("glycated serum proteins"[Mesh]) OR ("glycosuria"[Mesh]) OR (blood glucose control[Title/Abstract]) OR (fasting plasma glucose[Title/Abstract]) OR (fasting blood glucose[Title/Abstract]) OR (HbA1c[Title/Abstract]) OR (GSP[Title/Abstract]) OR (urine glucose[Title/Abstract]) OR (postprandial plasma glucose[Title/Abstract]))) NOT ((meta-analysis[Title]) OR (review[Title]) OR (systematic review[Title]) OR (Mendelian Randomization[Title])))	May 2, 2024	708
Web of Science	(((TI="sleep initiation and maintenance disorders" OR TI="disorders of initiating and maintaining sleep" OR TI="DIMS" OR TI="sleep initiation dysfunction*" OR TI="sleep initiation" OR TI="initiating sleep" OR TI="early awakening" OR TI="wake up early" OR TI="waking up early" OR TI="wakeful*" OR TI="sleeplessness" OR TI="sleepless" OR TI="sleep difficult*" OR TI="difficulty in falling asleep" OR TI="fall asleep" OR TI="falling asleep" OR TI="difficulty in maintaining sleep" OR TI="maintain sleep" OR TI="sleep maintenance" OR TI="maintaining sleep" OR TI="sleep impairment" OR TI="sleep disturbance" OR TI="sleep disorder" OR TI="insomnia" OR TI="sleep quality" OR TI="poor sleep" OR TI="sleep efficiency") OR (AB="sleep initiation and maintenance disorders" OR AB="disorders of initiating and maintaining sleep" OR AB="DIMS" OR AB="sleep initiation dysfunction*" OR AB="sleep initiation" OR AB="initiating sleep" OR AB="early awakening" OR AB="wake up early" OR AB="waking up early" OR AB="wakeful*" OR AB="sleeplessness" OR AB="sleepless" OR AB="sleep difficult*" OR AB="difficulty in falling asleep" OR AB="fall asleep" OR AB="falling asleep" OR AB="difficulty in maintaining sleep" OR AB="maintain sleep" OR AB="sleep	May 2, 2024	515

Database	Search strategy	Search date	Total number of identified articles
	<p> maintenance" OR AB="maintaining sleep" OR AB="sleep impairment" OR AB="sleep disturbance" OR AB="sleep disorder" OR AB="insomnia" OR AB="sleep quality" OR AB="poor sleep" OR AB="sleep efficiency")) AND ((TI="glycemic control" OR TI="blood glucose" OR TI="glycated hemoglobin" OR TI="glycated serum proteins" OR TI="glycosuria" OR TI="blood glucose control" OR TI="fasting plasma glucose" OR TI="fasting blood glucose" OR TI="HbA1c" OR TI="GSP" OR TI="urine glucose" OR TI="postprandial plasma glucose") OR (AB="glycemic control" OR AB="blood glucose" OR AB="glycated hemoglobin" OR AB="glycated serum proteins" OR AB="glycosuria" OR AB="blood glucose control" OR AB="fasting plasma glucose" OR AB="fasting blood glucose" OR AB="HbA1c" OR AB="GSP" OR AB="urine glucose" OR AB="postprandial plasma glucose")))) NOT (TI="meta-analysis" OR TI="review" OR TI="systematic review" OR TI="Mendelian Randomization") </p>		
Scopus	<p> (INDEXTERMS("sleep initiation maintenance disorders") OR TITLE-ABS("disorders of initiating maintaining sleep") OR TITLE-ABS("DIMS") OR TITLE-ABS("sleep initiation dysfunction*") OR TITLE-ABS("sleep initiation") OR TITLE-ABS("initiating sleep") OR TITLE-ABS("early awakening") OR TITLE-ABS("wake up early") OR TITLE-ABS("waking up early") OR TITLE-ABS("wakeful*") OR TITLE-ABS("sleeplessness") OR TITLE-ABS("sleepless") OR TITLE-ABS("sleep difficult*") OR TITLE-ABS("difficulty in falling asleep") OR TITLE-ABS("fall asleep") OR TITLE-ABS("falling asleep") OR TITLE-ABS("difficulty in maintaining sleep") OR TITLE-ABS("maintain sleep") OR TITLE-ABS("sleep maintenance") OR TITLE-ABS("maintaining sleep") OR TITLE-ABS("sleep impairment") OR TITLE-ABS("sleep disturbance") OR TITLE-ABS("sleep disorder") OR TITLE-ABS("insomnia") OR TITLE-ABS("sleep quality") OR TITLE-ABS("poor sleep") OR TITLE-ABS("sleep efficiency")) AND (INDEXTERMS("glycemic control") OR INDEXTERMS("blood glucose") OR INDEXTERMS("glycated hemoglobin") OR INDEXTERMS("glycated serum proteins") OR INDEXTERMS("glycosuria") OR TITLE-ABS("blood glucose control") OR TITLE-ABS("fasting plasma glucose") OR TITLE-ABS("fasting blood glucose") OR TITLE-ABS("HbA1c") OR TITLE-ABS("GSP") OR TITLE-ABS("urine glucose") OR TITLE-ABS("postprandial plasma glucose")) AND NOT INDEX(medline) AND NOT (TITLE("meta-analysis") OR TITLE("review") OR TITLE("systematic review") OR TITLE("Mendelian Randomization")) AND (LIMIT-TO(SUBJAREA,"MEDI")) AND (LIMIT-TO(DOCTYPE,"ar")) AND (LIMIT-TO(LANGUAGE,"English")) </p>	May 2, 2024	140

Table S2. The details of included articles

First Author	Year	Exposure	Indicator	Outcome	Indicator	Sample size	Details of participants				NOS score
							Region	Age*	Gender (male, %)	Diabetes status	
Cross-sectional studies											
Abdu et al. [1]	2023	Sleep quality	Low quality: PSQI ≥ 5; high quality: PSQI < 5	Glucose levels	HbA1c (%)	269	Qatar	51.0 ± 9.5	63.9	T2D population	7
Adler et al. [2]	2017	Sleep quality	SDSC	T1D	Clinical diagnosis	90	Israel	T1D population: 9.94 ± 1.66; non-diabetes population: 9.07 ± 1.73	48.89	T1D population and non-diabetes population	6
Al-Musharaf et al. [3]	2023	Sleep quality	Low quality: PSQI ≥ 5; high quality: PSQI < 5	Glucose levels	FPG (mg/dL)	487	Saudi Arabia	35.19 ± 12.74	34.1	Non-diabetes population	6
Aribas et al. [4]	2015	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	Glucose levels	FPG (mg/dL)	78	Turkey	Low sleep quality population: 50.6 ± 9.2; high sleep quality population: 47.7 ± 9.4	38.46	T2D population	6
Azuma et al. [5]	2019	Sleep quality	Questionnaire	Glucose levels	Adverse glycaemic control: HbA1c ≥ 6.5%; normal glycaemic control: HbA1c < 6.5%	6,025	Japan	≥ 20	57.43	-	4
Bani-Issa et al. [6]	2018	Sleep quality	Low quality: PSQI ≥ 5.5; high quality: PSQI < 5.5	Glucose levels	HbA1c (%)	268	United Arab Emirates	42.4 ± 12.5	38.06	T2D population	6

First Author	Year	Exposure	Indicator	Outcome	Indicator	Sample size	Details of participants				NOS score
							Region	Age*	Gender (male, %)	Diabetes status	
Barakat et al. [7]	2019	Sleep quality	Low quality: PSQI \geq 8; high quality: PSQI $<$ 8	Glucose levels	Adverse glycaemic control: HbA1c \geq 7%; normal glycaemic control: HbA1c $<$ 7%	1,211	Jordan	58.8 \pm 9.74	44.6	T2D population	3
Barikani et al. [8]	2019	Sleep quality	Low quality: PSQI \geq 6; high quality: PSQI $<$ 6	Glucose levels	HbA1c (%)	347	Iran	Low sleep quality population: 55.1 \pm 9.04; high sleep quality population: 53.3 \pm 8.4	26.1	T2D population	6
Barone et al. [9]	2015	Sleep quality	PSQI	T1D	Clinical diagnosis	27	Brazil	T1D population: 26.3 \pm 5.1; non-diabetes population: 28.8 \pm 5.3	44.44	T1D population and non-diabetes population	6
Bener et al. [10]	2020	Sleep quality	Low quality: PSQI $>$ 5; high quality: PSQI \leq 5	Glucose levels	Adverse glycaemic control: HbA1c \geq 7%; normal glycaemic control: HbA1c $<$ 7%	871	Turkey	-	37.89	T2D population	7
Caruso et al. [11]	2014	Sleep quality	SDSC	T1D	Clinical diagnosis	43	Australia	T1D population: 12.0 \pm 2.8; non-diabetes population: 11.2 \pm 2.8	56.1	T1D population and non-diabetes population	6

First Author	Year	Exposure	Indicator	Outcome	Indicator	Sample size	Details of participants				NOS score
							Region	Age*	Gender (male, %)	Diabetes status	
Cho et al. [12]	2023	Sleep quality	PSQI	Glucose levels	Adverse glycaemic control: HbA1c \geq 8%; normal glycaemic control: HbA1c < 8%	96	Korea	32.29 \pm 9.89	32.1	T1D population	5
Clark et al. [13]	2014	Insomnia	Karolinska Sleep Questionnaire (KSQ): an average frequency of the insomnia symptoms of "at least some times a week"	Glucose levels	Adverse glycaemic control: HbA1c \geq 6.5%; normal glycaemic control: HbA1c < 6.5%	1,629	Denmark	54 \pm 4	71.98	-	5
Colbay et al. [14]	2015	Sleep quality	Low quality: PSQI > 5; high quality: PSQI \leq 5	T2D	Clinical diagnosis	97	Turkey	T2D population: 51.4 \pm 8.3; non-diabetes population: 50.5 \pm 9.8	39.36	T2D population and non-diabetes population	6
Çömlek et al. [15]	2021	Sleep quality	PSQI	T1D	Clinical diagnosis	98	Turkey	T1D population: 14.3 \pm 1.7; non-diabetes population: 14.1 \pm 1.9	48.98	T1D population and non-diabetes population	6
Corrado et al. [16]	2024	Sleep quality	Low quality: PSQI \geq 5; high quality: PSQI < 5	Glucose levels	HbA1c (%)	117	Italy	Low sleep quality population: 42.4 \pm 14.3; high sleep quality population: 38.7 \pm 14.4	50.43	T1D population	6

First Author	Year	Exposure	Indicator	Outcome	Indicator	Sample size	Details of participants				NOS score
							Region	Age*	Gender (male, %)	Diabetes status	
Culver et al. [17]	2020	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	Glucose levels	FPG (mg/dL)	31	USA	Low sleep quality population: 28.8 ± 10.0; high sleep quality population: 29.8 ± 10.3	54.84	Non-diabetes population	6
Cunha et al. [18]	2008	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	Glucose levels	Adverse glycaemic control: HbA1c ≥ 7%; normal glycaemic control: HbA1c < 7%	50	Brazil	median: 62	24	T2D population	4
Del Brutto et al. [19]	2014	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	Glucose levels	FPG ≥ 100 mg/dL	635	Ecuador	59 ± 13	42	-	5
Demirtaş et al. [20]	2023	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	Glucose levels	Adverse glycaemic control: HbA1c ≥ 7%; normal glycaemic control: HbA1c < 7%	103	Turkey	53.19 ± 10.03	46.6	Diabetic population	5
DePietro et al. [21]	2017	Sleep efficiency	Wrist-actigraphy	Diabetes	Clinical diagnosis	212	USA	63.9 ± 11.1	40.1	Diabetic population and non-diabetes population	5
Ding et al. [22]	2019	Insomnia	Insomnia: ISI > 14; no insomnia: ISI ≤ 14	Glucose levels	HbA1c (%)	3,749	China	Insomnia population: 54.2 ± 8.3; non-insomnia population: 54.3 ± 8.6	57.3	T2D population	5

First Author	Year	Exposure	Indicator	Outcome	Indicator	Sample size	Details of participants				NOS score
							Region	Age*	Gender (male, %)	Diabetes status	
Dong et al. [23]	2023	Insomnia	Self-reported	Diabetes	Clinical diagnosis	3,382	China	Median: 41.0	89.92	Diabetic population and non-diabetes population	5
Fukui et al. [24]	2012	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	T2D	Clinical diagnosis	563	Japan	T2D population: 63.8 ± 10.0; non-diabetes population: 63.3 ± 4.1	100	T2D population and non-diabetes population	5
Gabbs et al. [25]	2022	Sleep quality	PSQI	T2D	Clinical diagnosis	240	Canada	T2D population: 15.11 ± 2.46; non-diabetes population: 16.31 ± 2.86	37.08	T2D population and non-diabetes population	6
Gara et al. [26]	2019	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	Glucose levels	HbA1c (%)	444	India	53.33 ± 10.49	42.34	T2D population	5
Gozashti et al. [27]	2016	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	Glucose levels	HbA1c (%)	118	Iran	58 ± 11	76.27	T2D population	6
Haliloglu et al. [28]	2020	Sleep quality	PSQI	T2D	Clinical diagnosis	78	Turkey	T2D population: 53.8 ± 12.5; non-diabetes population: 45.7 ± 14.1	35.9	T2D population and non-diabetes population	5
Hayashino et al. [29]	2013	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	Glucose levels	HbA1c (%)	1,513	Japan	63.7 ± 12.6	50.6	T1D population and T2D population	6
Hilmisson et al. [30]	2019	Sleep quality	Low quality: Sleep quality index (SQI) <60; high quality: SQI ≥ 80	Glucose levels	FPG (mg/dL)	72	USA	Low sleep quality population: 6.3 ± 1.2; high sleep quality population: 6.3 ± 1.0	53.53	-	7

First Author	Year	Exposure	Indicator	Outcome	Indicator	Sample size	Details of participants				NOS score
							Region	Age*	Gender (male, %)	Diabetes status	
Huang et al. [31]	2017	Sleep quality	Low quality: PSQI > 7; high quality: PSQI ≤ 7	Glucose levels	HbA1c (%)	81	China	Low sleep quality population: 66.2 ± 8.8; high sleep quality population: 65.6 ± 10.3	53.33	T2D population	6
Hung et al. [32]	2013	Sleep quality	PSQI	Glucose levels	IFG: FPG of 5.6–7.0 mmol/L and 2-h post load glucose <7.8 mmol/L; otherwise, no IFG:	1,335	China	IFG population: 51.4 ± 8.8; non-IFG population: 50.0 ± 8.1	60.79	Non-diabetes population	5
Hur et al. [33]	2020	Sleep efficiency	Wrist-actigraphy	T2D	Clinical diagnosis	60	Korea	T2D population: 47.3 ± 10.68; non-diabetes population: 42.9 ± 12.45	53.33	T2D population and non-diabetes population	6
Imes et al. [34]	2022	Insomnia	Insomnia: ISI ≥ 10; no insomnia: ISI < 10	Glucose levels	HbA1c (%)	149	USA	56.3 ± 10.5	51.4	T2D population	6
Inoue et al. [35]	2021	Insomnia	Questionnaire	Diabetes	Clinical diagnosis	7,324	Japan	Diabetes population: 62.0 ± 15.1; non-diabetes population: 44.7 ± 16.5	49.66	Diabetic population and non-diabetes population	5
Ishibashi et al. [36]	2020	Sleep quality	PSQI	T2D	Clinical diagnosis	178	Japan	T2D population: 48.6 ± 0.7; non-diabetes population: 48.6 ± 1.2	62.92	T2D population and non-diabetes population	6
Jain et al. [37]	2012	Insomnia	-	Glucose levels	HbA1c (%)	19	USA	Insomnia population: 51.6 ± 4.6; non-insomnia population: 54.2 ± 2.4	21.05	T2D population	5

First Author	Year	Exposure	Indicator	Outcome	Indicator	Sample size	Details of participants				NOS score
							Region	Age*	Gender (male, %)	Diabetes status	
Jemere et al. [38]	2019	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	Glucose levels	Adverse glycaemic control: FPG > 130 mg/dL or < 70 mg/dL; otherwise, normal adverse glycaemic control	99	Ethiopia	T2D population: 50.14 ± 11.3; non-diabetes population: 49.9 ± 9.7	52.53	T2D population and non-diabetes population	6
Kachi et al. [39]	2011	Insomnia	Questionnaire	Glucose levels	Adverse glycaemic control: HbA1c ≥ 6%; normal glycaemic control: HbA1c < 6%	1,042	Japan	43.9 ± 10.1	100	-	4
Keckeis et al. [40]	2010	Insomnia	-	Glucose levels	Adverse glycaemic control: HbA1c, ≥ 5.5% and FPG ≥ 100 mg/dL; otherwise, normal glycaemic control	52	Germany	Insomnia population: 49.1 ± 9.7; non-insomnia population: 46.8 ± 7.7	46.3	Non-diabetes population	4
Keskin et al. [41]	2015	Sleep quality	Low quality: PSQI ≥ 5; high quality: PSQI < 5	Glucose levels	Adverse glycaemic control: HbA1c > 6.5%; normal glycaemic control: HbA1c ≤ 6.5%	564	Turkey	Median: 58	33.04	T2D population	6

First Author	Year	Exposure	Indicator	Outcome	Indicator	Sample size	Details of participants				NOS score
							Region	Age*	Gender (male, %)	Diabetes status	
Khakurel et al. [42]	2020	Sleep quality	PSQI (≥ 8 , < 8)	Glucose levels	Adverse glycaemic control: HbA1c $\geq 7\%$; normal glycaemic control: HbA1c $< 7\%$	208	Nepal	55.36 \pm 10.58	45.2	T2D population	5
Kita et al. [43]	2012	Sleep quality	Athens Insomnia Scale (AIS)	Diabetes	Clinical diagnosis	2,862	Japan	Diabetes population: 50.3 \pm 4.0; non-diabetes population: 46.2 \pm 6.1	79.3	Diabetic population and non-diabetes population	6
Kostkova et al. [44]	2018	Sleep efficiency	Video polysomnography	T1D	Clinical diagnosis	104	Slovakia	T1D population: 14.4 \pm 2.5; non-diabetes population: 13.9 \pm 0.33	40.38	T1D population and non-diabetes population	6
Lee et al. [45]	2016	Sleep quality	Low quality: PSQI ≥ 5 ; high quality: PSQI < 5	Glucose levels	IFG: 110 mg/dL \leq FPG \leq 125 mg/dL; otherwise, no IFG	463	China	57.0 \pm 10.2	45.6	Non-diabetes population	6
Lou et al. [46]	2014	Sleep quality	Low quality: PSQI > 5 ; high quality: PSQI ≤ 5	Glucose levels	IFG: 110 mg/dL \leq FPG \leq 125 mg/dL; otherwise, no IFG	15,145	China	47.6 \pm 15.1	49.9	Non-diabetes population	6
Lou et al. [47]	2012	Sleep quality	Self-reported sleep quality	T2D	Clinical diagnosis	16,893	China	45.1 \pm 14.4	45.6	T2D population and non-diabetes population	6

First Author	Year	Exposure	Indicator	Outcome	Indicator	Sample size	Details of participants				NOS score
							Region	Age*	Gender (male, %)	Diabetes status	
Lou et al. [48]	2015	Sleep quality	Low quality: PSQI > 7; high quality: PSQI ≤ 7	Glucose levels	Adverse glycaemic control: HbA1c ≥ 6.5%; normal glycaemic control: HbA1c < 6.5%	944	China	64.1 ± 10.2	38.7	T2D population	6
Lou et al. [49]	2015	Sleep quality	Questionnaire	T2D	Clinical diagnosis	4,213	China	44.8 ± 14.7	45.4	T2D population and non-diabetes population	6
Martyn-Nemeth et al. [50]	2018	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	Glucose levels	HbA1c (%)	48	USA	27.0 ± 5.8	37	T1D population	6
Mehrdad et al. [51]	2021	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	Glucose levels	HbA1c (%)	266	Iran	47.00 ± 19.04	34.6	T1D population and T2D population	5
Meng et al. [52]	2015	Sleep quality	Low quality: PSQI < 7; high quality: PSQI ≥ 7	Glucose levels	HbA1c (%)	332	China	Low sleep quality population: 59.36 ± 9.39; high sleep quality population: 53.09 ± 13.60	56.63	T2D population	5
Mokhlesi et al. [53]	2019	Sleep quality	PSQI	T2D	Clinical diagnosis	962	USA	52.2 ± 9.5	54.6	T2D population and non-diabetes population	5
Mokhlesi et al. [54]	2019	Sleep quality	Sleep Disturbances Scale questionnaire, low quality: ≥52; high quality: <52	T2D	Clinical diagnosis	96	USA	14.1 ± 2.1	29.9	T2D population and non-diabetes population	6

First Author	Year	Exposure	Indicator	Outcome	Indicator	Sample size	Details of participants				NOS score
							Region	Age*	Gender (male, %)	Diabetes status	
Narisawa et al. [55]	2017	Sleep quality	PSQI	T2D	Clinical diagnosis	1,244	Japan	T2D population: 56.8 ± 9.62 ; non-diabetes population: 56.1 ± 9.56	75.88	T2D population and non-diabetes population	6
Nefs et al. [56]	2015	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	Glucose levels	HbA1c (%)	243	Netherlands	62 ± 9	54	T2D population	4
O et al. [57]	2023	Insomnia	Insomnia: ISI > 14; no insomnia: ISI ≤ 14	Glucose levels	HbA1c (%)	986	China	Insomnia population: 62.6 ± 2.5 ; non-insomnia population: 62.5 ± 2.6	58.14	T2D population	5
Osonoi et al. [58]	2015	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	Glucose levels	HbA1c (%)	539	Japan	57.8 ± 8.6	62.98	T2D population	5
Pan et al. [59]	2022	Insomnia	Insomnia: ISI > 14; no insomnia: ISI ≤ 14	Glucose levels	FPG (mg/dL)	118	China	Insomnia population: 72.33 ± 5.95 ; non-insomnia population: 71.84 ± 6.24	51.69	-	5
Pillar et al. [60]	2003	Sleep efficiency	Polysomnography	T1D	Clinical diagnosis	30	Israel	T1D population: 12.6 ± 2.9 ; non-diabetes population: 13.3 ± 1.1	53.33	T1D population and non-diabetes population	6
Qin et al. [61]	2016	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	Glucose levels	IFG: FPG ≥ 126 mg/dL; no IFG: FPG < 126 mg/dL	15,145	China	47.6 ± 15.1	49.9	-	6

First Author	Year	Exposure	Indicator	Outcome	Indicator	Sample size	Details of participants				NOS score
							Region	Age*	Gender (male, %)	Diabetes status	
Reutrakul et al. [62]	2011	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	GDM	A 100 g oral glucose tolerance test during the second trimester of gestation	142	USA	28.5 ± 5.5	0	GDM population	3
Richa et al. [63]	2023	Sleep quality	PSQI (≥5, <5)	Glucose levels	Adverse glycaemic control: HbA1c ≥ 7%; normal glycaemic control: HbA1c < 7%	192	India	52.7 ± 10.3	53.13	T2D population	6
Rizza et al. [64]	2021	Sleep quality	Low quality: PSQI ≥ 5; high quality: PSQI < 5	Glucose levels	HbA1c (%)	273	Italy	Low sleep quality population: 38.7 ± 6.3; high sleep quality population: 36.9 ± 6.5	32.23	Non-diabetes population	5
Ruangchaisiwaw et al. [65]	2024	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	Glucose levels	Adverse glycaemic control: HbA1c ≥ 7%; normal glycaemic control: HbA1c < 7%	127	Thailand	66.2 ± 7.3	48.03	T2D population	5

First Author	Year	Exposure	Indicator	Outcome	Indicator	Sample size	Details of participants				NOS score
							Region	Age*	Gender (male, %)	Diabetes status	
Sakamoto et al. [66]	2018	Sleep quality	Low quality: PSQI \geq 6; high quality: PSQI $<$ 6	Glucose levels	Adverse glycaemic control: HbA1c $>$ 7%; normal glycaemic control: HbA1c \leq 7%	3,294	Japan	Median: 65	61.08	T2D population	5
Shamshirgaran et al. [67]	2017	Sleep quality	Low quality: PSQI $>$ 5; high quality: PSQI \leq 5	Glucose levels	Adverse glycaemic control: HbA1c \geq 7%; normal glycaemic control: HbA1c $<$ 7%	256	Iran	54.06 \pm 9.09	29	T2D population	6
Silva-Costa et al. [68]	2020	Insomnia	Questionnaire	Glucose levels	Adverse glycaemic control: HbA1c \geq 6.5%; normal glycaemic control: HbA1c $<$ 6.5%	6,231	Brazil	Insomnia population: 56.3 \pm 9.2; non-insomnia population: 55.6 \pm 9.2	100	-	5
Simon et al. [69]	2018	Sleep efficiency	Wrist-actigraphy	Diabetes	Clinical diagnosis	22	USA	Diabetes population: 14.09 \pm 2.2; non-diabetes population: 13.5 \pm 2.3	40.91	Diabetic population and non-diabetes population	5
Suárez-Torres et al. [70]	2023	Insomnia	Insomnia: AIS $>$ 6; no insomnia: AIS \leq 6	Glucose levels	Adverse glycaemic control: HbA1c \geq 7%; normal glycaemic control: HbA1c $<$ 7%	202	Mexico	Median: 53	29	T2D population	7

First Author	Year	Exposure	Indicator	Outcome	Indicator	Sample size	Details of participants				NOS score
							Region	Age*	Gender (male, %)	Diabetes status	
Sugano et al. [71]	2022	Insomnia	Questionnaire	Glucose levels	IFG: FPG \geq 110 mg/dL; no IFG: FPG < 110 mg/dL	755	Japan	50.1 \pm 7.2	100	-	5
Suteau et al. [72]	2020	Sleep quality	Low quality: PSQI > 5; high quality: PSQI \leq 5	Glucose levels	HbA1c (%)	315	France	47 \pm 15	46	T1D population	4
Telford et al. [73]	2019	Sleep quality	Low quality: PSQI > 5; high quality: PSQI \leq 5	Glucose levels	HbA1c (%)	281	USA	61.9 \pm 8.8	51.6	T2D population	4
Trento et al. [74]	2008	Sleep efficiency	Wrist-actigraphy	T2D	Clinical diagnosis	70	Italy	T2D population: 61.0 \pm 4.9; non-diabetes population: 58.0 \pm 9.7	61.43	T2D population and non-diabetes population	5
Tsai et al. [75]	2011	Sleep quality	Low quality: PSQI > 7; high quality: PSQI \leq 7	Glucose levels	Adverse glycaemic control: HbA1c \geq 7%; normal glycaemic control: HbA1c < 7%	46	China	60.11 \pm 9.69	60.87	T2D population	4
Vargas et al. [76]	2021	Sleep quality	Low quality: PSQI \geq 5; high quality: PSQI < 5	Glucose levels	FPG (mg/dL)	26	Chile	39.9 \pm 11.94	0	-	5
Vézina-Im et al. [77]	2021	Insomnia	PSQI	Diabetes	Clinical diagnosis	151	Canada	Adults	19.9	T1D population, T2D population and non-diabetes population	7
Vgontzas et al. [78]	2009	Insomnia	A complaint of insomnia with a duration of at least 1 y	Glucose levels	FPG (mg/dL)	1,221	USA	-	48	T2D population and non-diabetes population	5

First Author	Year	Exposure	Indicator	Outcome	Indicator	Sample size	Details of participants				NOS score
							Region	Age*	Gender (male, %)	Diabetes status	
Wu et al. [79]	2023	Sleep quality	PSQI	PGDM or GDM	The 75-g OGTT method	1,335	China	GDM population: 31.73 ± 4.41; non-diabetes population: 28.27 ± 3.56	0	PGDM population, GDM population, and non-diabetes population	5
Xu et al. [80]	2019	Sleep quality	Low quality: PSQI > 7; high quality: PSQI ≤ 7	Glucose levels	Adverse glycaemic control: HbA1c ≥ 7%; normal glycaemic control: HbA1c < 7%	944	China	Range: 30-89	35.7	T2D population	6
Yang et al. [81]	2021	Sleep quality	Low quality: PSQI > 7; high quality: PSQI ≤ 7	Glucose levels	HbA1c (%)	70	China	50.1 ± 11.1	63.96	T2D population	5
Yoshida et al. [82]	2018	Insomnia	Low quality: PSQI ≥ 5.5; high quality: PSQI < 5.5	Glucose levels	HbA1c (%)	503	Japan	Insomnia population: 61.3 ± 13.6; non-insomnia population: 64.9 ± 11.9	58.05	T2D population	4
Zhu et al. [83]	2014	Sleep quality	Low quality: PSQI ≥ 8; high quality: PSQI < 8	Glucose levels	FPG (mmol/L)	206	China	57.23 ± 11.24	66	T2D population	6
Zubair et al. [84]	2018	Sleep quality	PSQI	T2D	Clinical diagnosis	100	Pakistan	50 ± 7	38	T2D population and non-diabetes population	5
Case-control studies											
Agyekum et al. [85]	2023	Sleep quality	PSQI	T2D	Clinical diagnosis	360	Ghana	T2D population: 52.0 ± 7.9; non-diabetes population: 48.6 ± 10.6	36.11	T2D population and non-diabetes population	8

First Author	Year	Exposure	Indicator	Outcome	Indicator	Sample size	Details of participants					NOS score
							Region	Age*	Gender (male, %)	Diabetes status		
Al-Musharaf et al. [86]	2022	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	Glucose levels	FPG (mg/dL)	92	Saudi Arabia	21.1 ± 1.5	0	-	8	
Bahadur et al. [87]	2022	Sleep quality	CSHQ	T1D	Clinical diagnosis	124	Turkey	T1D population: 8.81 ± 2.28; non-diabetes population: 8.14±2.3	38.71	T1D population and non-diabetes population	7	
Henriksen et al. [88]	2023	Insomnia	Questionnaire	T2D	Clinical diagnosis	20,295	Norway	T2D population: 69.9 ± 9.8; non-diabetes population:65.3 ± 11.2	44.78	T2D population and non-diabetes population	9	
van Dijk et al. [89]	2011	Sleep quality	PSQI	T1D	Clinical diagnosis	198	Netherlands	T1D population: 43.9 ± 1.3; non-diabetes population: 44.1 ± 1.3	55.56	T1D population and non-diabetes population	8	
Cohort studies												
LeBlanc et al. [90]	2018	Insomnia	physician-entered diagnosis of insomnia or use medications for sleep problems	T2D	Clinical diagnosis	81,233	USA	57.5 ± 13.6	46.37	Non-diabetes population	7	
Zou et al. [91]	2022	Sleep quality	Low quality: PSQI > 5; high quality: PSQI ≤ 5	GDM	a 75 g oral glucose tolerance test	3,329	China	GDM population: 30.08 ± 4.28; non-diabetes population: 28.43 ± 3.95	0	Non-diabetes population	6	

PSQI – Pittsburgh Sleep Quality Index, SDSC – The Sleep Disturbance Scale for Children, CSHQ – The Children’s Sleep Habits Questionnaire, ISI – Insomnia Severity Index, AIS – Athens Insomnia Scale, HbA1c – haemoglobin A1c, FPG – fasting plasma glucose, IFG – impaired fasting glucose, T1D – type 1 diabetes, T2D – type 2 diabetes, GDM – gestational diabetes mellitus, PGDM – pregestational diabetes mellitus, NOS – The Newcastle-Ottawa Scale.

* If there is no specific explanation, age is presented as mean (±standard deviation) by default.

Table S3. The details of quality assessment

Study	Selection	Comparability	Exposure/outcome	Total score
Cross-sectional studies				
Abdu et al. [1]	111	11	11	7
Adler et al. [2]	011	11	11	6
Al-Musharaf et al. [3]	011	11	11	6
Aribas et al. [4]	011	11	11	6
Azuma et al. [5]	010	01	11	4
Bani-Issa et al. [6]	101	11	11	6
Barakat et al. [7]	001	00	11	3
Barikani et al. [8]	011	11	11	6
Barone et al. [9]	011	11	11	6
Bener et al. [10]	111	11	11	7
Caruso et al. [11]	101	11	11	6
Cho et al. [12]	101	01	11	5
Clark et al. [13]	101	01	11	5
Colbay et al. [14]	011	11	11	6
Çömlek et al. [15]	011	11	11	6
Corrado et al. [16]	011	11	11	6
Culver at al.[17]	011	11	11	6
Cunha et al. [18]	111	00	10	4
Del Brutto et al. [19]	011	01	11	5
Demirtaş et al. [20]	011	01	11	5
DePietro et al. [21]	011	01	11	5
Ding et al. [22]	011	01	11	5
Dong et al. [23]	110	01	11	5

Study	Selection	Comparability	Exposure/outcome	Total score
Fukui et al. [24]	011	01	11	5
Gara et al. [26]	011	01	11	5
Gabbs et al. [25]	011	11	11	6
Gozashti et al. [27]	011	11	11	6
Haliloglu et al. [28]	011	01	11	5
Hayashino et al. [29]	011	11	11	6
Hilmisson et al. [30]	111	11	11	7
Huang et al. [31]	011	11	11	6
Hung et al. [32]	011	01	11	5
Hur et al. [33]	011	11	11	6
Imes et al. [34]	111	01	11	6
Inoue et al. [35]	110	01	11	5
Ishibashi et al. [36]	011	11	11	6
Jain et al. [37]	010	01	11	4
Jemere et al. [38]	011	11	11	6
Kachi et al. [39]	010	01	11	4
Keckeis et al. [40]	010	01	11	4
Keskin et al. [41]	011	11	11	6
Khakurel et al. [42]	101	10	11	5
Kita et al. [43]	111	01	11	6
Kostkova et al. [44]	011	11	11	6
Lee et al. [45]	011	11	11	6
Lou et al. [46]	111	01	11	6
Lou et al. [47]	110	11	11	6
Lou et al. [48]	111	01	11	6

Study	Selection	Comparability	Exposure/outcome	Total score
Lou et al. [49]	111	01	11	6
Martyn-Nemeth et al. [50]	011	11	11	6
Mehrdad et al. [51]	101	01	11	5
Meng et al. [52]	011	01	11	5
Mokhlesi et al. [53]	011	01	11	5
Mokhlesi et al. [54]	011	11	11	6
Narisawa et al. [55]	011	11	11	6
Nefs et al. [56]	001	01	11	4
O et al. [57]	011	01	11	5
Osonoi et al. [58]	011	01	11	5
Pan et al. [59]	001	11	11	5
Pillar et al. [60]	011	11	11	6
Qin et al. [61]	111	01	11	6
Reutrakul et al. [62]	001	00	11	3
Richa et al. [63]	111	01	11	6
Rizza et al. [64]	011	01	11	5
Ruangchaisiwawet et al. [65]	011	01	11	5
Sakamoto et al. [66]	011	01	11	5
Shamshirgaran et al. [67]	011	11	11	6
Silva-Costa et al. [68]	110	01	11	5
Simon et al. [69]	001	11	11	5
Suárez-Torres et al. [70]	111	11	11	7
Sugano et al. [71]	101	01	11	5
Suteau et al. [72]	001	01	11	4
Telford et al. [73]	001	01	11	4

Study	Selection	Comparability	Exposure/outcome	Total score
Trento et al. [74]	001	11	11	5
Tsai et al. [75]	001	01	11	4
Vargas et al. [76]	001	11	11	5
Vézina-Im et al. [77]	111	11	11	7
Vgontzas et al. [78]	110	01	11	5
Wu et al. [79]	101	01	11	5
Xu et al. [80]	111	01	11	6
Yang et al. [81]	001	11	11	5
Yoshida et al. [82]	001	01	11	4
Zhu et al. [83]	111	01	11	6
Zubair et al. [84]	011	01	11	5
Case-control studies				
Agyekum et al. [85]	1111	01	111	8
Al-Musharaf et al. [86]	1011	11	111	8
Bahadur et al. [87]	1001	11	111	7
Henriksen et al. [88]	1111	11	111	9
van Dijk et al. [89]	1011	11	111	8
Cohort studies				
LeBlanc et al. [90]	1111	00	111	7
Zou et al. [91]	0111	00	111	6

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Figure S1. The meta-analysis comparing the occurrence of low sleep quality between groups of adverse/normal glycaemic control

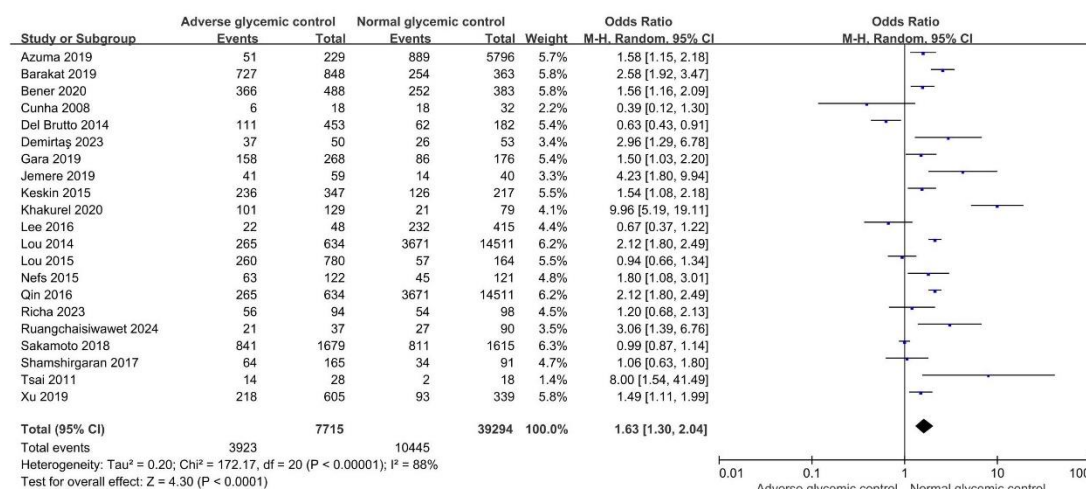


Figure S2. The meta-analysis comparing the occurrence of insomnia between groups of adverse/normal glycaemic control

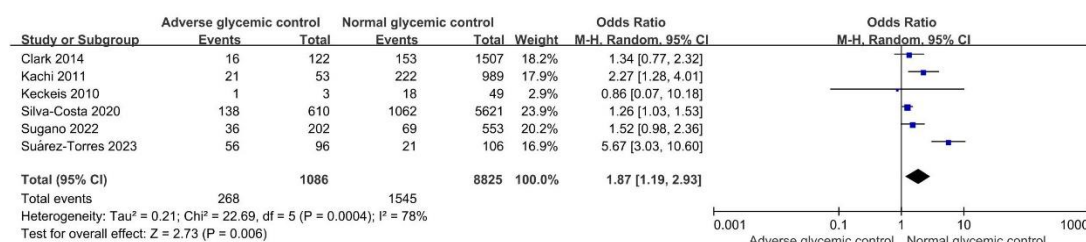


Figure S3. The meta-analysis comparing the occurrence of low sleep quality between groups with/without diabetes

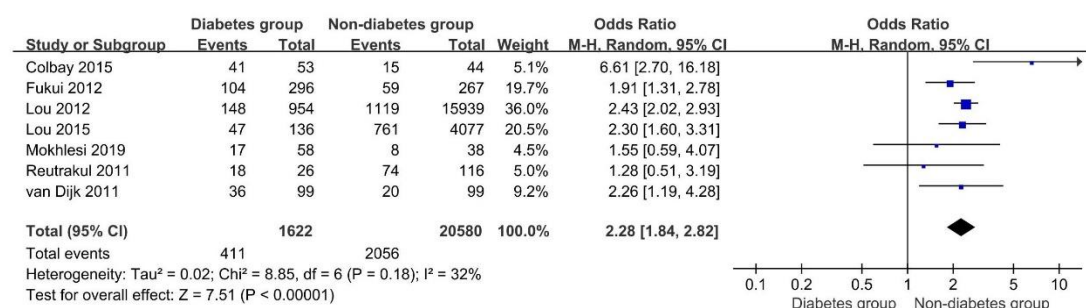


Figure S4. The meta-analysis comparing the occurrence of insomnia between groups with/without diabetes

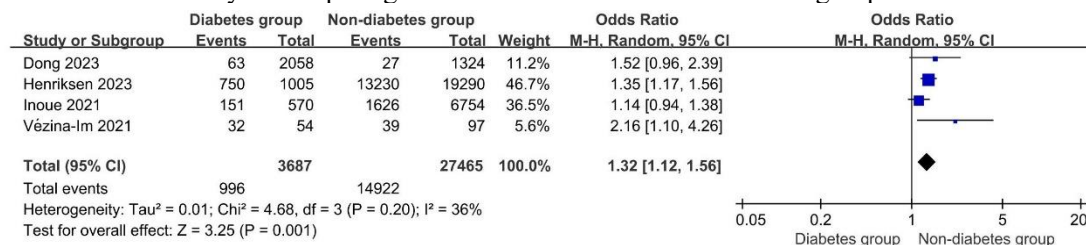


Figure S5. The meta-analysis comparing the glucose levels of groups with high/low sleep quality

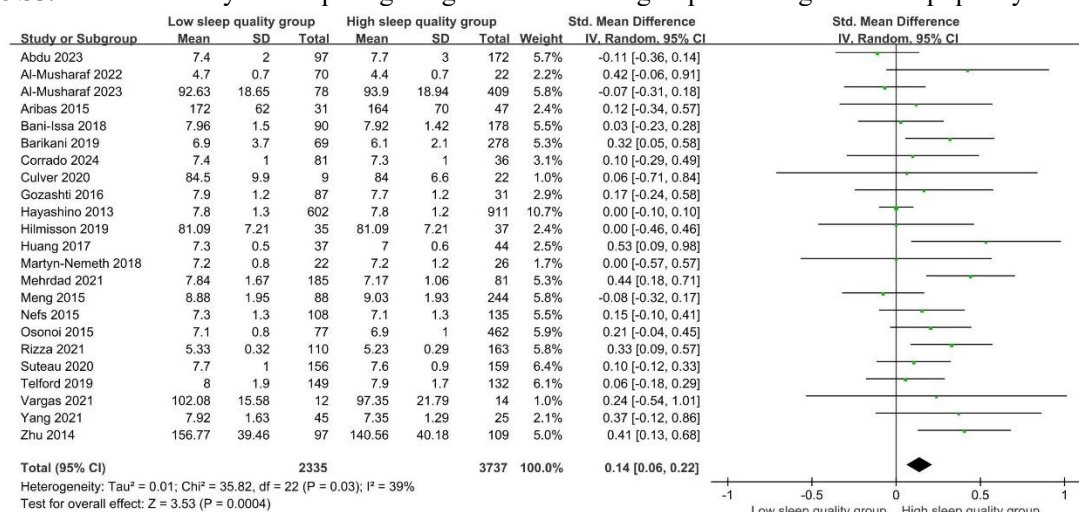


Figure S6. The meta-analysis comparing the glucose levels of groups with/without insomnia

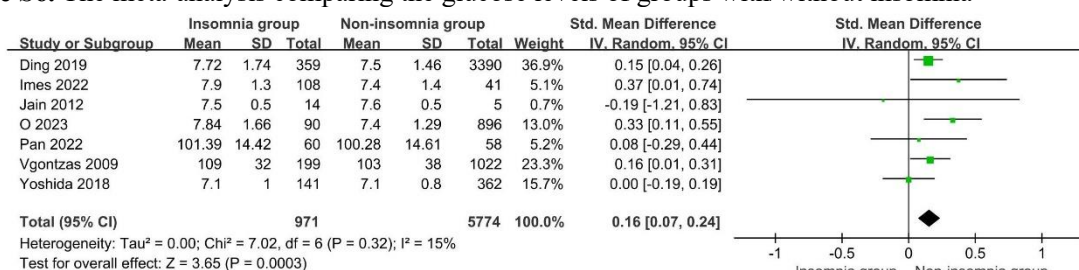


Figure S7. The meta-analysis comparing the sleep quality scores between groups with/without diabetes

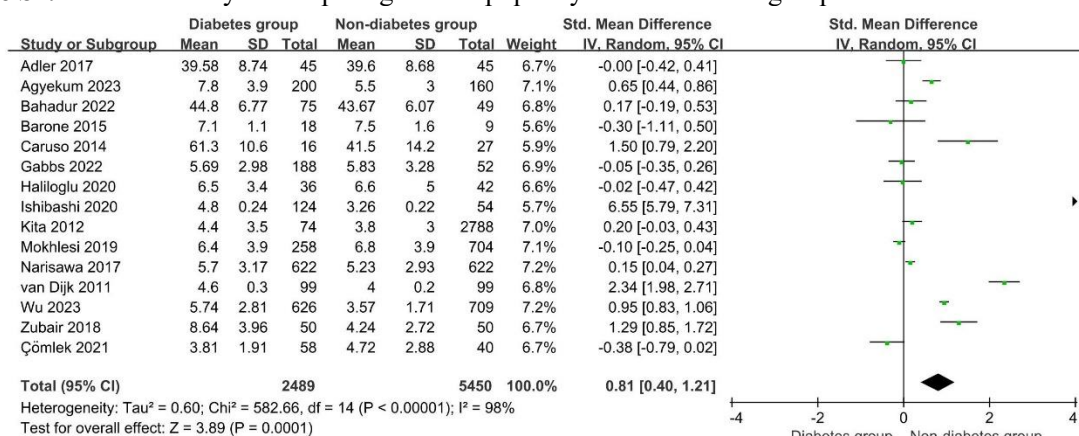


Figure S8. The meta-analysis comparing the sleep quality scores between groups of adverse/normal glycaemic control

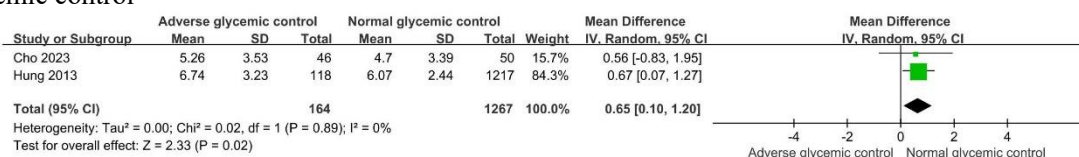


Figure S9. The meta-analysis comparing the sleep efficiency between groups with/without diabetes

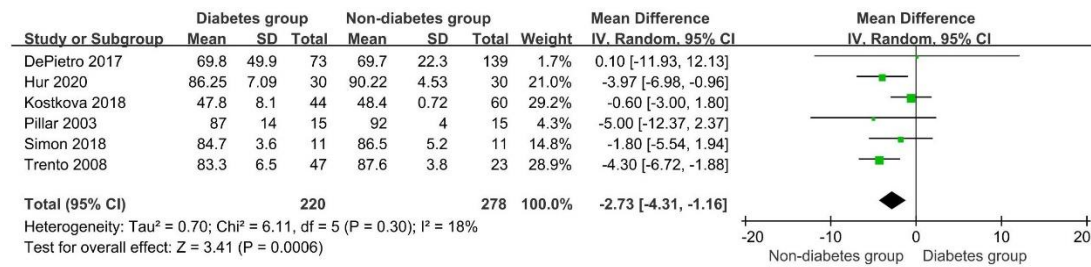


Figure S10. The meta-analysis comparing the risk of diabetes between groups with/without insomnia (related symptoms)



Figure S11. The leave-one-out sensitivity analysis

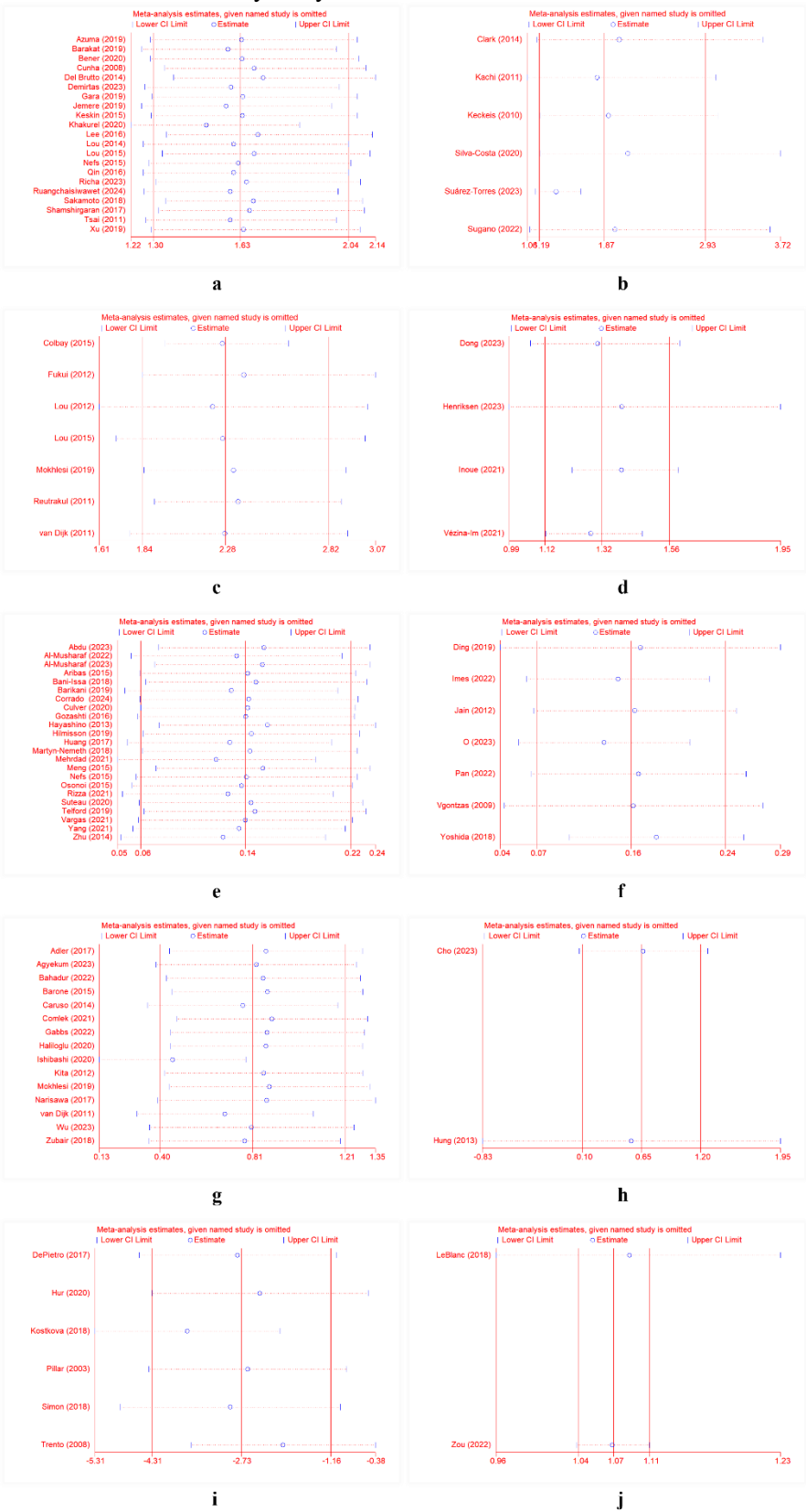
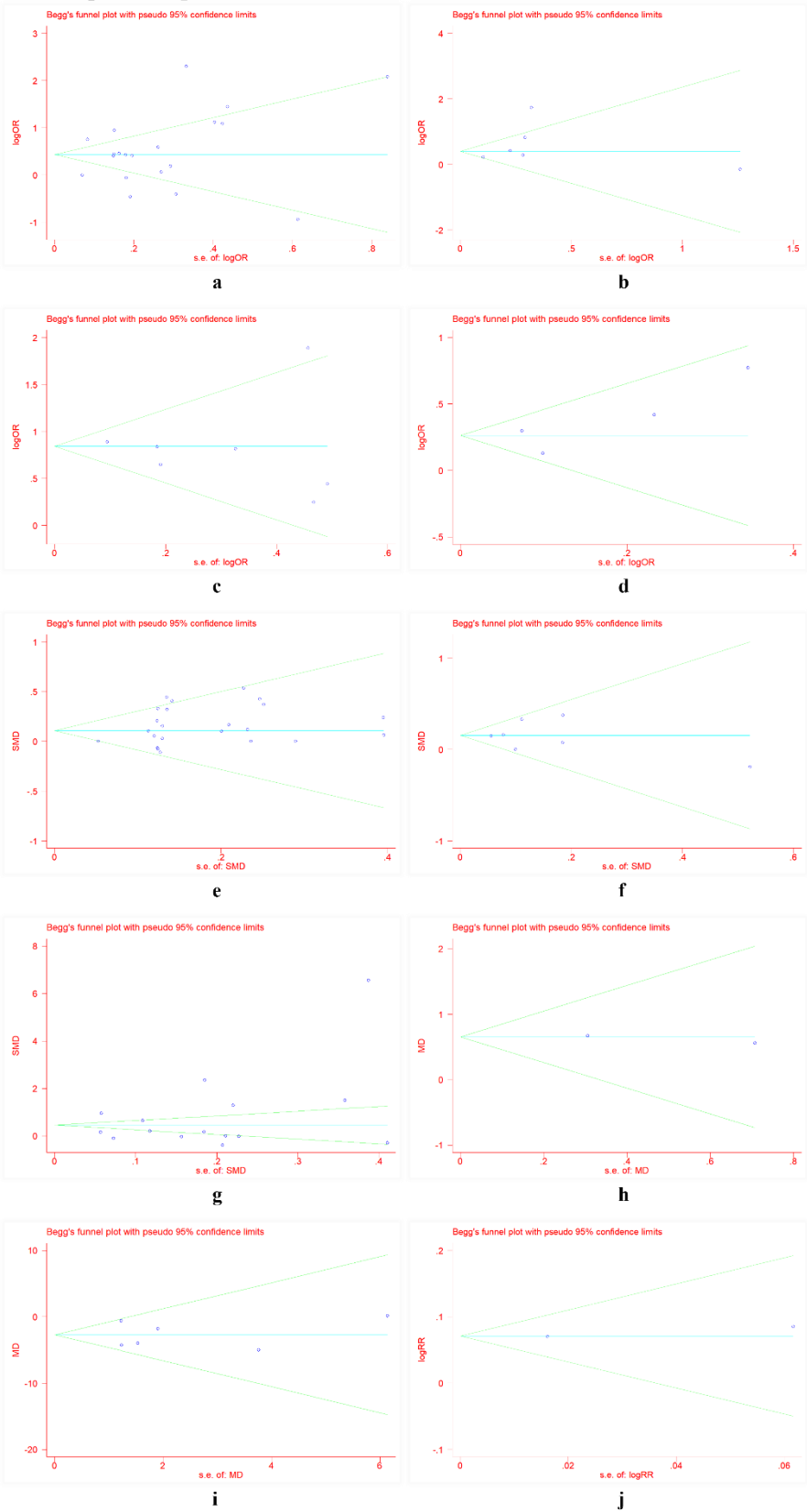


Figure S12. The funnel plots for publication bias



Appendix S1

NEWCASTLE - OTTAWA QUALITY ASSESSMENT SCALE

CASE CONTROL STUDIES

Note: A study can be awarded a maximum of one star for each numbered item within the Selection and Exposure categories. A maximum of two stars can be given for Comparability.

Selection

- 1) Is the case definition adequate?
 - a) yes, with independent validation *
 - b) yes, eg record linkage or based on self reports
 - c) no description
- 2) Representativeness of the cases
 - a) consecutive or obviously representative series of cases *
 - b) potential for selection biases or not stated
- 3) Selection of Controls
 - a) community controls *
 - b) hospital controls
 - c) no description
- 4) Definition of Controls
 - a) no history of disease (endpoint) *
 - b) no description of source

Comparability

- 1) Comparability of cases and controls on the basis of the design or analysis
 - a) study controls for _____ (Select the most important factor.) *
 - b) study controls for any additional factor * (This criteria could be modified to indicate specific control for a second important factor.)

Exposure

- 1) Assessment of exposure
 - a) secure record (eg surgical records) *
 - b) structured interview where blind to case/control status *
 - c) interview not blinded to case/control status
 - d) written self report or medical record only
 - e) no description
- 2) Same method of ascertainment for cases and controls
 - a) yes *
 - b) no
- 3) Non-Response rate
 - a) same rate for both groups *
 - b) non respondents described
 - c) rate different and no designation

NEWCASTLE - OTTAWA QUALITY ASSESSMENT

SCALE COHORT STUDIES

Note: A study can be awarded a maximum of one star for each numbered item within the Selection and Outcome categories. A maximum of two stars can be given for Comparability

Selection

- 1) Representativeness of the exposed cohort
 - a) truly representative of the average _____(describe) in the community *
 - b) somewhat representative of the average _____in the community *
 - c) selected group of users eg nurses, volunteers
 - d) no description of the derivation of the cohort
- 2) Selection of the non exposed cohort
 - a) drawn from the same community as the exposed cohort *
 - b) drawn from a different source
 - c) no description of the derivation of the non exposed cohort
- 3) Ascertainment of exposure
 - a) secure record (eg surgical records) *
 - b) structured interview *
 - c) written self report
 - d) no description
- 4) Demonstration that outcome of interest was not present at start of study
 - a) yes *
 - b) no

Comparability

- 1) Comparability of cohorts on the basis of the design or analysis
 - a) study controls for _____(select the most important factor) *
 - b) study controls for any additional factor * (This criteria could be modified to indicate specific control for a second important factor.)

Outcome

- 1) Assessment of outcome
 - a) independent blind assessment *
 - b) record linkage *
 - c) self report
 - d) no description
- 2) Was follow-up long enough for outcomes to occur
 - a) yes (select an adequate follow up period for outcome of interest) *
 - b) no
- 3) Adequacy of follow up of cohorts
 - a) complete follow up - all subjects accounted for *
 - b) subjects lost to follow up unlikely to introduce bias - small number lost - > _____% (select an adequate %) follow up, or description provided of those lost) *
 - c) follow up rate < _____% (select an adequate %) and no description of those lost
 - d) no statement

NEWCASTLE - OTTAWA QUALITY ASSESSMENT SCALE

(adapted for cross-sectional studies)

Selection: (Maximum 3 stars)

1) Representativeness of the sample:

- a) truly representative of the average in the target population (all subjects or random sampling) ✱
- b) somewhat representative of the average in the target population (non-random sampling) ✱
- c) selected group of users
- d) no description of the sampling strategy

2) Non-respondents:

- a) comparability between respondents and non-respondents characteristics is established, and the response rate is satisfactory ✱
- b) the response rate is unsatisfactory, or the comparability between respondents and non-respondents is unsatisfactory
- c) no description of the response rate or the characteristics of the responders and the non-responders

3) Ascertainment of the exposure (risk factor):

- a) validated measurement tool ✱
- b) non-validated measurement tool, but the tool is available or described
- c) no description of the measurement tool

Comparability: (Maximum 2 stars)

1) The subjects in different outcome groups are comparable, based on the study design or analysis.

Confounding factors are controlled:

- a) the study controls for the most important factor (select one) ✱
- b) the study control for any additional factor ✱

Outcome: (Maximum 2 stars)

1) Assessment of the outcome:

- a) independent blind assessment ✱
- b) record linkage ✱
- c) self-report
- d) no description

2) Statistical test:

- a) the statistical test used to analyze the data is clearly described and appropriate, and the measurement of the association is presented, including confidence intervals and the probability level (P value) ✱
- b) the statistical test is not appropriate, not described or incomplete